

The Speaker Tracker

An autonomous lecture recording system
User Manual

About The Speaker Tracker Autonomous Lecture Recording System

The Speaker Tracker system is an easy to use option for recording lectures in a classroom or lecture hall setting. Using various motion detection techniques, a pan/tilt/zoom camera tracks a lecturer across a stage or classroom without the use of a camera operator. An easy to use interface makes recording a simple process, providing high quality video footage. Many specialization features allow the user to optimize the Speaker Tracker program to best fit their needs.

This project was designed for Dr. Cristinel Ababei at North Dakota State University as part of a two-semester long capstone project to fulfill the requirements for a Bachelor of Science in Electrical Engineering.

Table of Contents

<i>Equipment.....</i>	<i>4-5</i>
<i>Equipment Setup.....</i>	<i>5-7</i>
<i>Software Installation.....</i>	<i>7</i>
<i>Introduction to User Interface.....</i>	<i>8-16</i>
<i>Home Tab.....</i>	<i>8-9</i>
<i>Settings Tab.....</i>	<i>10-13</i>
<i>Video Options Tab.....</i>	<i>14-15</i>
<i>Help Tab.....</i>	<i>16</i>
<i>Pointer.....</i>	<i>17</i>
<i>Getting Started.....</i>	<i>18</i>
<i>Troubleshooting.....</i>	<i>19-20</i>

Equipment

The Speaker Tracker System comes equipped with everything you need to operate it.

Description of parts:

Flash drive: The USB flash drive contains the installer for the Speaker Tracker program.



Camera: The Cisco PVC300 is a Pan/Tilt/Zoom camera. Further documentation for the camera can be found under the Help tab of the User Interface.



Microphone: The supplied microphone is a cardioid microphone.



Microphone cable: XLR to 3.5mm



Microphone Stand

Laptop: Any laptop with a Windows XP operating system can be used to operate this system.

Stand: This stand will be used to hold the microphone, laptop and camera.



Equipment Setup

1. To begin equipment setup, wheel the stand to the back of the classroom where the lecture will be recorded. If not already done, unfold the top of the stand to reveal the widest table surface.
2. Position the laptop in the middle of the stand and the camera off to one side with the lens of the camera facing the front of the room. Place the microphone in the microphone stand. The microphone should be positioned on the other side of the stand with the top of the microphone facing the front of the room.
3. Connect an Ethernet cable from the camera to the back of the computer.



4. Connect the power cord from the back of the camera to an outlet.



5. Connect the end of the microphone to the end of the adaptor cord.



Figure 2: End of microphone

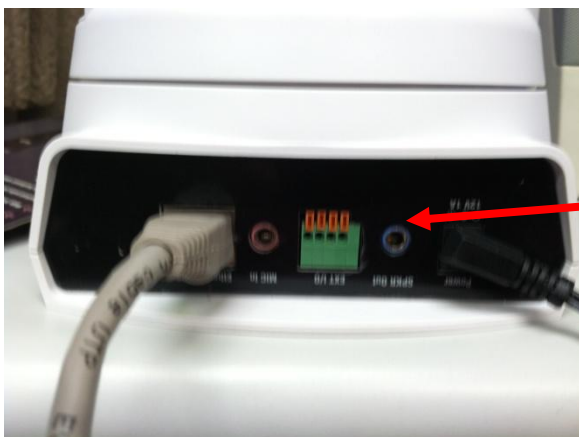


Figure 1: End of adaptor



Figure 3: Assembled microphone and adaptor

6. Connect microphone to the back of the camera.



7. Final setup



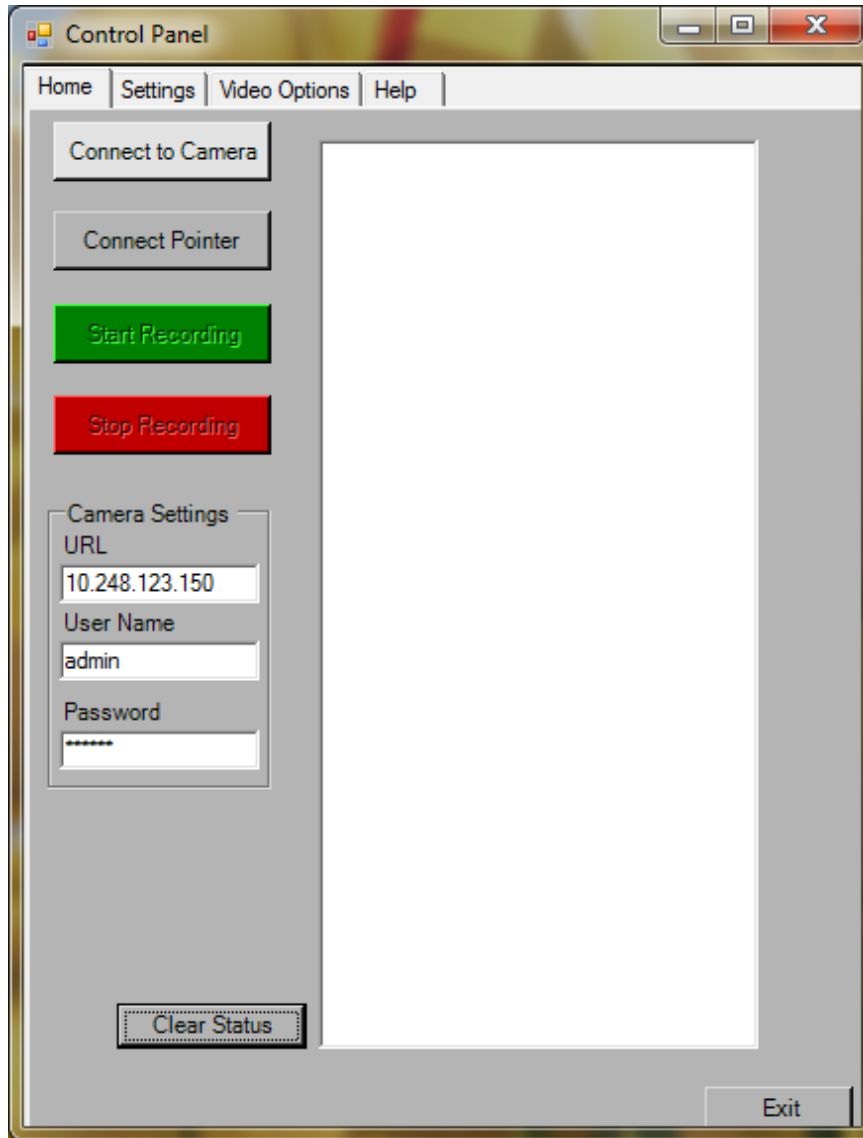
Congratulations! You're done with the equipment setup.

Software Installation

1. Insert the USB flash drive.
2. Open the folder and run the installer. Click "Next" when prompted. If Windows User Account Control (UAC) prompts you for permission, select "Yes". When the installer is finished, click close.
3. To launch the program, double click the Speaker Tracker icon.

Introduction to User Interface

Home Tab



Connect to Camera: By clicking on this button, a connection to the camera is established. The process of connecting to the camera may take up to 3 minutes.

Connect to Pointer: The user has the option of using a presentation pointer. If the use of a pointer is desired, plug the USB dongle into the computer and click the Connect to Pointer button. This establishes a connection to the pointer.

Start Recording: This button enables recording. When the button is pressed, two windows will open; one window shows the live video feed and the other window shows where motion is being

detected. A video file will also be recorded at the location the user specified under the Settings tab.

Stop Recording: When this button is pressed, video will stop being recorded.

Camera Settings: URL contains the IP address that the camera is setup under. User name is the user name you have setup to access the camera. Password is the setup password for the camera.

Clear Status: Clears all program messages in the text box found on this tab.

Exit: Closes the program and all associated processes and windows.

Settings Tab

Environment Settings	
<input type="radio"/>	Alone
<input type="radio"/>	Classroom
<input type="radio"/>	Noisy Classroom
<input type="radio"/>	Custom
<button>Load Custom</button>	
<button>Save Custom</button>	

Threshold Settings	
Minimum Pixel Threshold	60
Maximum Pixel Threshold	255
PixelCount Threshold	90
Box Threshold	10
Look list Dead box TH	8
Live Box Max	100
Cumulative Count Max	15000
Ideal dx	6
Ideal dy	6
Ideal cx	8
Ideal cy	10
Move Votes TH	2
cx TH	1
cy TH	1
dx TH	1
dy TH	1
Move delay	1
<button>Reset to Default</button>	

Environment Settings: By selecting the appropriate radio button, you are able to adjust the threshold settings to your situational needs. The “alone” setting adjusts the thresholds to the optimal values for a situation where the lecturer is alone in a room. The “classroom” setting adjusts the thresholds for a typical classroom situation. You also have the option of creating your own environmental setting.

To create your own custom environmental setting: Change the thresholds to your desired values and when you are done, click the “Save Custom” button. When the pop up window opens, give the file your desired name and click the “Save” button. This will save your settings for future use. To load the custom settings, click the “Load Custom” button and select your desired file. Multiple custom settings may be saved.

Reset to Default: This button returns the thresholds to their default values set by the software designers.

Threshold Settings

Minimum Pixel Threshold The algorithm that processes frames converts a colored frame to black and white. During this transition, we can tell the algorithm what value (intensity or R, G, or B) the pixel must have to be counted as an “on” or white pixel, as opposed to an “off” or black on. This setting is the minimum intensity of red, green, or blue required to be counted as “on” during the conversion. A lower value will make the routine count more pixels as “on”, a higher number will be more selective on which values are considered “on.”

Maximum Pixel Threshold As in the description for “Minimum Pixel Threshold,” this value describes the maximum value a pixel can have to be counted as “on” during RGB to black and white conversion. A higher value (255 is the maximum allowed) will allow more pixels to be counted as “on” and reduce selectivity. A lower value will make the system more selective.

Pixel Count Threshold This value is similar to the Minimum Pixel Threshold and Maximum Pixel Threshold settings. The black and white frame after conversion from color contains a value associated with the “strength” of that pixel. The Pixel Count Threshold value determines the minimum pixel strength to be counted during processing. A lower value will count more converted pixels and be less selective. A higher value will be more selective.

Box Threshold During processing, the frame is divided to boxes. This value sets the minimum number of pixels above the Pixel Count Threshold required before the box is counted. If the number of pixels above the Pixel Count Threshold is below the Box Threshold, the entire box isn’t counted during analysis. A lower value will make the algorithm less selective. A higher value will be more selective.

Look list Dead box TH The program keeps track of which boxes on the frame have had motion in the past. The location of these boxes and those adjacent to them are held on a list called the “Look list.” This value determines how long boxes stay on the list without any motion in them before they are removed. A lower value means boxes will be removed sooner, a higher value means boxes will be removed after more frames. The boxes on the look list are indicated by blue rectangles on the visual display of the camera’s video.

Live Box Max To reduce the processing of invalid frames, the algorithm compares the number of boxes with active motion to this value. If the number of “live” boxes (boxes with valid and active motion) exceeds this limit, the frame is ignored and not processed. A higher value will allow more frames to be processed but may have the algorithm respond to noisy frames. A lower value will be more selective, but may not process some valid frames.

Cumulative Count Max As with the Live Box Max, this value sets how the algorithm will respond to very active frames. This value represents the maximum number of active pixels on the frame (indicating the

pixel changed between the current frame and the previous frame). If the number of pixels that changed between frames exceeds this value, the current frame will not be processed by the algorithm. A higher value will allow more frames to be processed and be less selective. A lower value will be more selective.

Ideal dx This value sets the ideal width of the motion on the frame, as measured by boxes. A higher value will result in a higher zoom level than a lower value. Note that this value is only an ideal, and the camera will not be able to exactly reach this level due to limitations on the optical zoom available.

Ideal dy This value sets the ideal height of the motion on the frame, as measured by boxes. A higher value will result in a higher zoom level than a lower value. Note that this value is only an ideal, and the camera will not be able to exactly reach this level due to limitations on the optical zoom available.

Ideal cx This value sets the ideal horizontal center of the motion on the frame, as measured by boxes. A higher value will move the ideal center to the right and will result in the camera aiming more to the left of the center of motion on the frame. A lower value will result in the opposite behavior.

Ideal cy This value sets the ideal vertical center of the motion on the frame, as measured by boxes. A higher value will move the ideal center lower and will result in the camera aiming more above the center of motion on the frame. A lower value will result in the opposite behavior.

Move Votes TH The processing algorithm uses a voting scheme to determine how to move the camera. If any of the thresholds above are not met (ideal dx, ideal dy, ideal cx, ideal cy), the algorithm adds one “vote” to a direction of motion or zoom that will serve to correct the error. Once the number of votes for any direction of motion or zoom exceeds this limit, the camera will be sent a command. A lower value of this threshold will make the camera more responsive, but may result in an unnecessary amount of camera motion (and lower video quality). A higher value will make the camera less responsive to transient motion in the frame, but may make the system less responsive to the movements of the target lecturer.

cx TH This value sets the amount of “slop” allowed between the actual and ideal horizontal center of motion in the frame, in boxes. A lower value will make the system more responsive to the horizontal difference between the ideal and actual value. A higher value will make the algorithm more tolerant of the difference.

cy TH This value sets the amount of “slop” allowed between the actual and ideal vertical center of motion in the frame, in boxes. A lower value will make the system more responsive to the vertical difference between the ideal and actual value. A higher value will make the algorithm more tolerant of the difference.

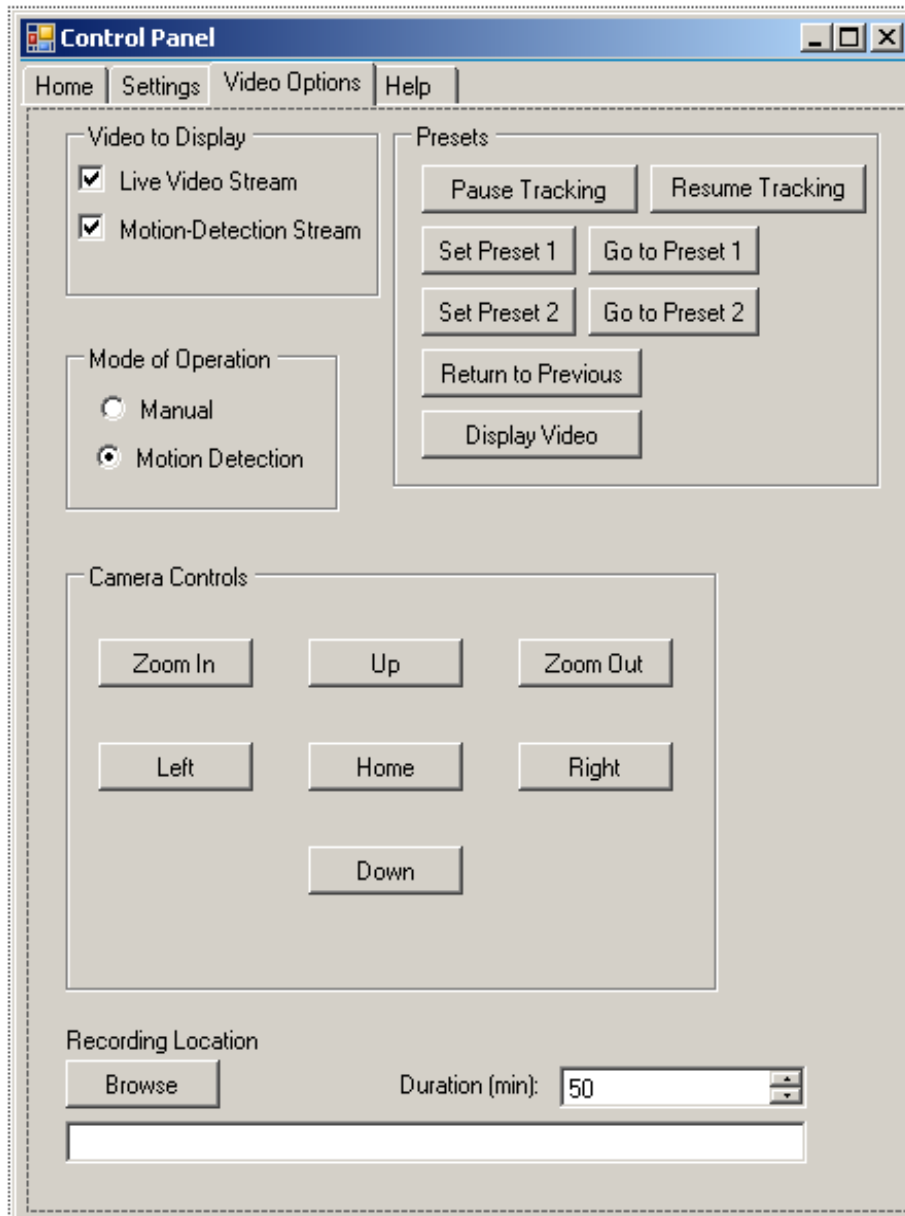
dx TH This value sets the amount of “slop” allowed between the actual and ideal width of the motion in the frame, in boxes. A lower value will make the system more responsive to the width difference

between the ideal and actual value. A higher value will make the algorithm more tolerant of the difference.

dy TH This value sets the amount of “slop” allowed between the actual and ideal height of the motion in the frame, in boxes. A lower value will make the system more responsive to the height difference between the ideal and actual value. A higher value will make the algorithm more tolerant of the difference.

Move delay While the camera is in motion, the frames it feeds the algorithm will be significantly different from each other, and if processed would show almost the entire frame as motion. To combat this drawback, the algorithm doesn’t process a number of frames after a move command is sent to the camera, that number set by the Move delay value. A higher number will make the algorithm ignore more frames after a move command, and may help the camera ignore “motion” that results from the camera itself moving. A lower value will ignore fewer frames, which will increase the system’s responsiveness, but may process frames that contain “motion” from the camera’s own movements.

Video Options Tab



Video to Display: There are two options within the “Video to Display” group box: “Live Video Stream” and “Motion-Detection Stream”. These check boxes control which video stream is shown when the “Start Recording” button is pressed on the “Home” tab. “Live Video Stream” shows the video as it is being recorded. “Motion-Detection Steam” shows the motion-detection algorithm in action. On the video for the Motion-Detection stream, you will see red and blue boxes. Blue boxes show where the program is looking for motion and red boxes indicate that motion is being detected.

Presets: The “Presets” buttons allow the user to press a button and have the camera move to particular location in order to look at the board or PowerPoint slide.

1. **Set Preset 1:** In order to set a preset location, move the camera to the desired location using the “Camera Control” buttons. Once the camera is in the desired location, click the “Set Preset 1” button to save the location.
2. **Set Preset 2:** Sets up a second preset recording location. To set Preset 2, follow the same directions as for Preset 1, but click the “Set Preset 2” button this time.
3. **Go to Preset 1:** Sends the camera to the Preset 1 location.
4. **Go to Preset 2:** Sends the camera to the Preset2 location.
5. **Return to Previous:** Returns the camera to its previous location.
6. **Display Video:** If one of the video stream windows is closed, click this button to reopen the video stream window that is checked.
7. **Pause Tracking:** Disables motion tracking.
8. **Resume Tracking:** Re-enables motion tracking.

Camera Controls

1. **Up:** Moves the camera up.
2. **Down:** Moves the camera down.
3. **Right:** Moves the camera right.
4. **Left:** Moves the camera left.
5. **Home:** Moves the camera to its manufacturer set home position.
6. **Zoom In:** Zooms the camera in.
7. **Zoom Out:** Zooms the camera out.

Recording Location:

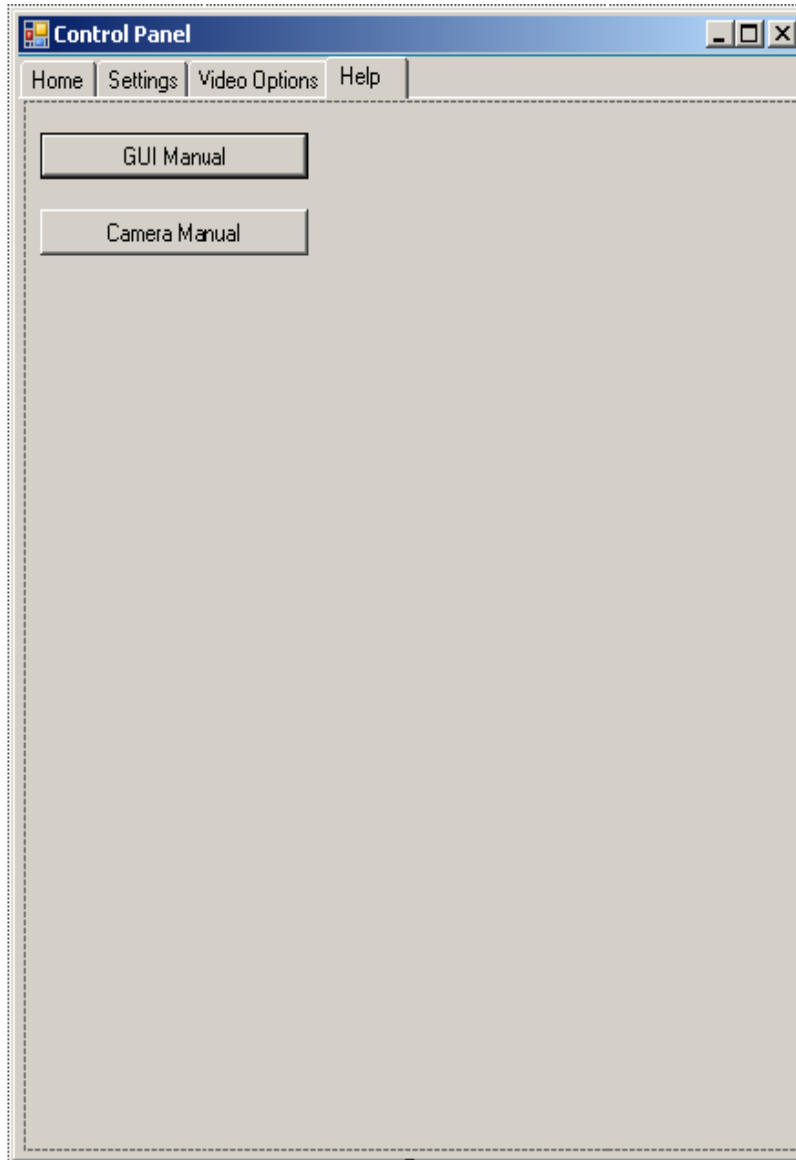
To set the recording location, hit the “Browse” button and browse to where you would like a video file to be recorded.

Mode of Operation:

1. **Manual:** By selecting this setting, the motion detection algorithm is disabled and the camera will only move if the user manually moves it using the “Camera Control” buttons.
2. **Motion Detection:** By selecting this setting, the motion detection algorithm is enabled and determines the camera movement. The camera can also be moved manually using the “Camera Control” buttons.

Duration: Set the duration of the recording in minutes. You may stop the recording at any time by hitting the “Stop Recording” button on the “Home” tab.

Help Tab



GUI Manual: The User's Manual can be opened by clicking on this button.

Camera Manual: The manual for the Cisco PVC300 PTZ camera can be opened by clicking on this button.

Pointer

The buttons on the pointer correspond to the following buttons found in the “Preset” group on the “Video Options” tab of the user interface:

Go to Preset 1

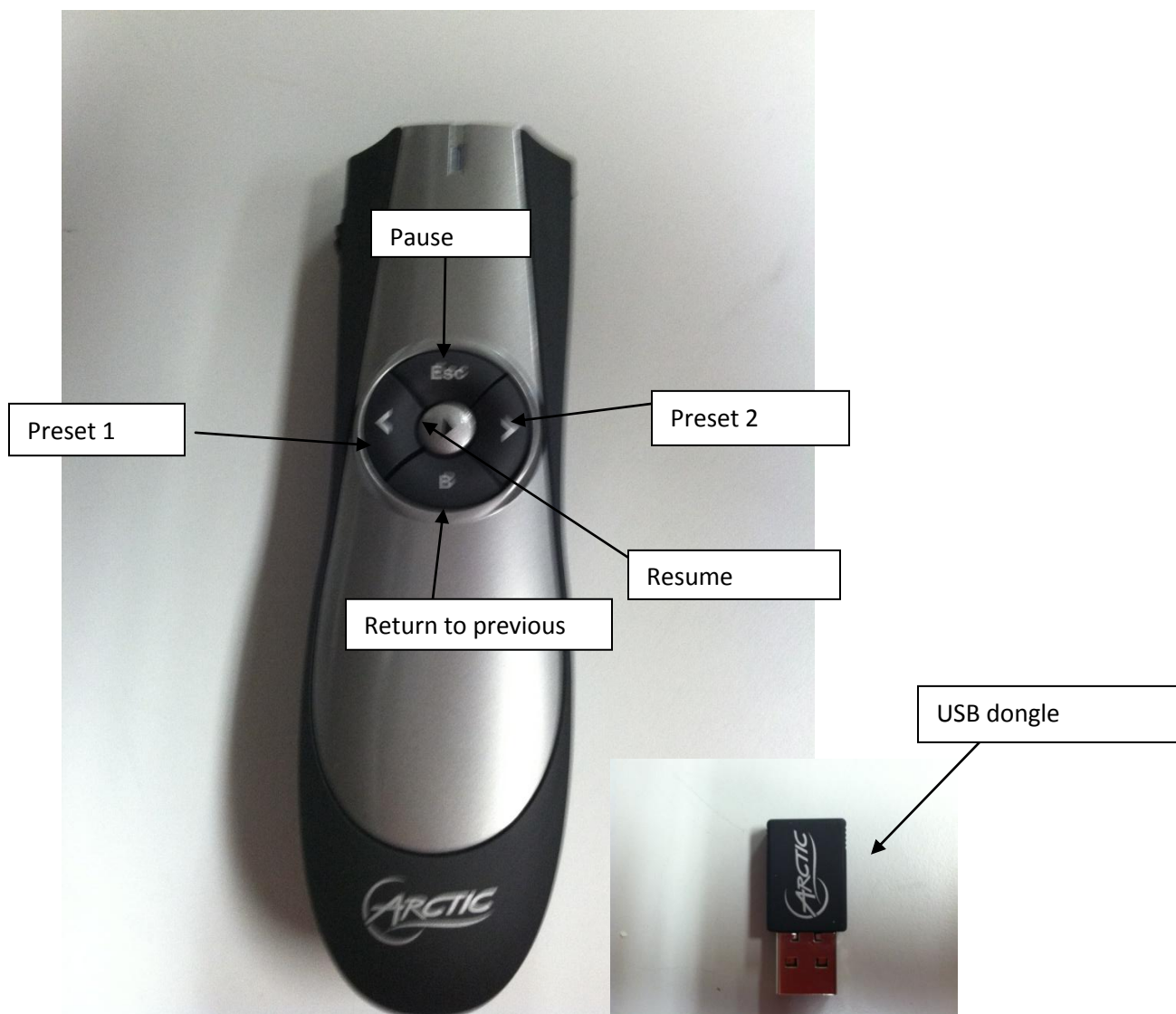
Go to Preset 2

Return to Previous

Pause Tracking

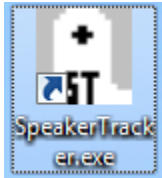
Resume Tracking

To turn on the laser pointer, slide the switch on the side of the pointer to the “on” position.



Getting Started

1. To begin, launch the Speaker Tracker program by clicking the icon that was installed on your desktop.



2. Verify the information under "Camera Settings" is correct on the "Home" Tab; if needed, modify them.
3. Once camera settings are verified, click the "Connect to Camera" button and wait for a successful camera connection message to be displayed in the text box.
4. Connect the USB dongle for the presentation pointer to the USB port of the laptop if its use is desired. If the use of a pointer is not desired, skip to Step 6.
5. Once the USB dongle of the pointer is connected, click the "Connect to Pointer" button.
6. Navigate to the "Settings" tab of the user interface and adjust the threshold settings to the desired values. Threshold settings are explained in more detail on pages 9-10.
7. Navigate to the "Video Options" tab.
8. Check which video you would like to be displayed using the check boxes found under "Video to Display".
9. Click the "Show Video" button and set the presets. More detailed instructions for setting the presets can be found on pages 11 and 12 of this manual.
10. Choose your mode of operation. The modes of operation are explained in more detail on page 12.
11. Set the destination for the recorded video using the "Browse" button found under "Recording Location".
12. Set the duration of the recording in minutes. The max recording time is 4 hours.
13. Navigate back to the "Home" Tab. When you are ready to begin your lecture, press the "Start Recording" button and begin lecturing.
14. When the lecture is finished, hit the "Stop Recording" button. The recorded video of your lecture can be found at the location you specified earlier.
15. To exit the Speaker Tracker program, you may either press the "Exit" button or click the red "X" in the upper right hand corner of the program.

Troubleshooting

Video quality is poor / glitchy / looks like The Matrix.

This is a known hardware issue with the Cisco camera. Some options to remedy this are as follows.

1. Make sure the computer used meets minimum hardware requirements. An Intel Core 2 processor or equivalent with a clock speed greater than 1.6 GHz is required.
2. Make sure another program isn't over-taxing the CPU. Using the Task Manager, make sure the CPU utilization never exceeds 90 % while running the SpeakerTracker program.
3. Turn down the maximum frame rate in the Cisco options interface. Keeping the frame rate at or below 15 fps at 640 x 480 resolution insures not too many copied frames are being injected into the output file.

Camera connection is unsuccessful

There are several possible causes of this problem:

1. The Camera's IP was not entered correctly
 - a. Try accessing the camera via a web browser by entering the camera's IP address as the URL.
 - i. If you don't see the camera's homepage, consult the Cisco manual to change the camera's settings.
 - ii. If you do see the camera's homepage, ensure you can connect to it by opening a command prompt and using the 'ping' command. If the camera replies, see 3. If not, see (1.a.i)
2. The laptop and camera are not on the same Subnet
 - a. Open the computer's control panel and open "Network Connections"
 - b. Right click on "Local Area Connection" and select "Properties"
 - c. Select IP (v4) and select "Properties"
 - d. Change the computer's IP to have the same first 3 sets of values as the camera's IP, with a different last value
 - e. Set the computer's Subnet Mask as 255.255.255.0
 - f. Retry the connection
3. The User Name or Password is incorrect
 - a. Try to reconfigure the camera using the camera's web interface. If this is unsuccessful, see the Cisco manual
4. The Camera and computer aren't physically connected
 - a. Plug one end of an Ethernet (Cat 5) cable into the camera and other into the computer
5. The camera isn't the one that came with the system
 - a. The camera used in the SpeakerTracker cannot be replaced with a different model. Buy a Cisco PVC300.
6. The camera doesn't have power

- a. Plug the camera into a wall outlet with the supplied power cord

The camera didn't record for long enough

1. The duration of the video recording session can be set using the "Duration" drop box in the Video Options tab
2. If the Stop Recording button is pressed, the system will stop recording video. Do not press "Stop Recording" unless you wish to stop recording video.

I can't find the recorded video file

1. The video will be saved in the location specified by the "Recording Location" text box in the Video Options tab. Look at this location.
 - a. If the location specified doesn't exist, the video may not be recorded
 - b. If the location has write or access protection, the video may not be recorded
 - c. In case of (a) or (b), choose a different recording location and try again.

I can't open the recorded video file

1. Try using a media player that supports MPEG4, such as VLC

The system doesn't follow me quickly enough

1. Adjust the tracking settings using the "Settings" tab and following the advice of this manual

This system tracks on noise/students/ghosts/striped shirts

1. Adjust the tracking settings using the "Settings" tab and following the advice of this manual

I don't understand how to work the system

1. This Document was originally a Spanish love story about a man named "Manual" that has since been translated into English. If you read it, you may find deeper meaning in your life and a new-found ability to understand the mysterious. Also, you might find instructions on how to operate the SpeakerTracker system.